Airborne Compact Atmospheric Mapper (ACAM)

Goddard Space Flight Center Atmospheric Chemistry and Dynamics Branch

Team members:

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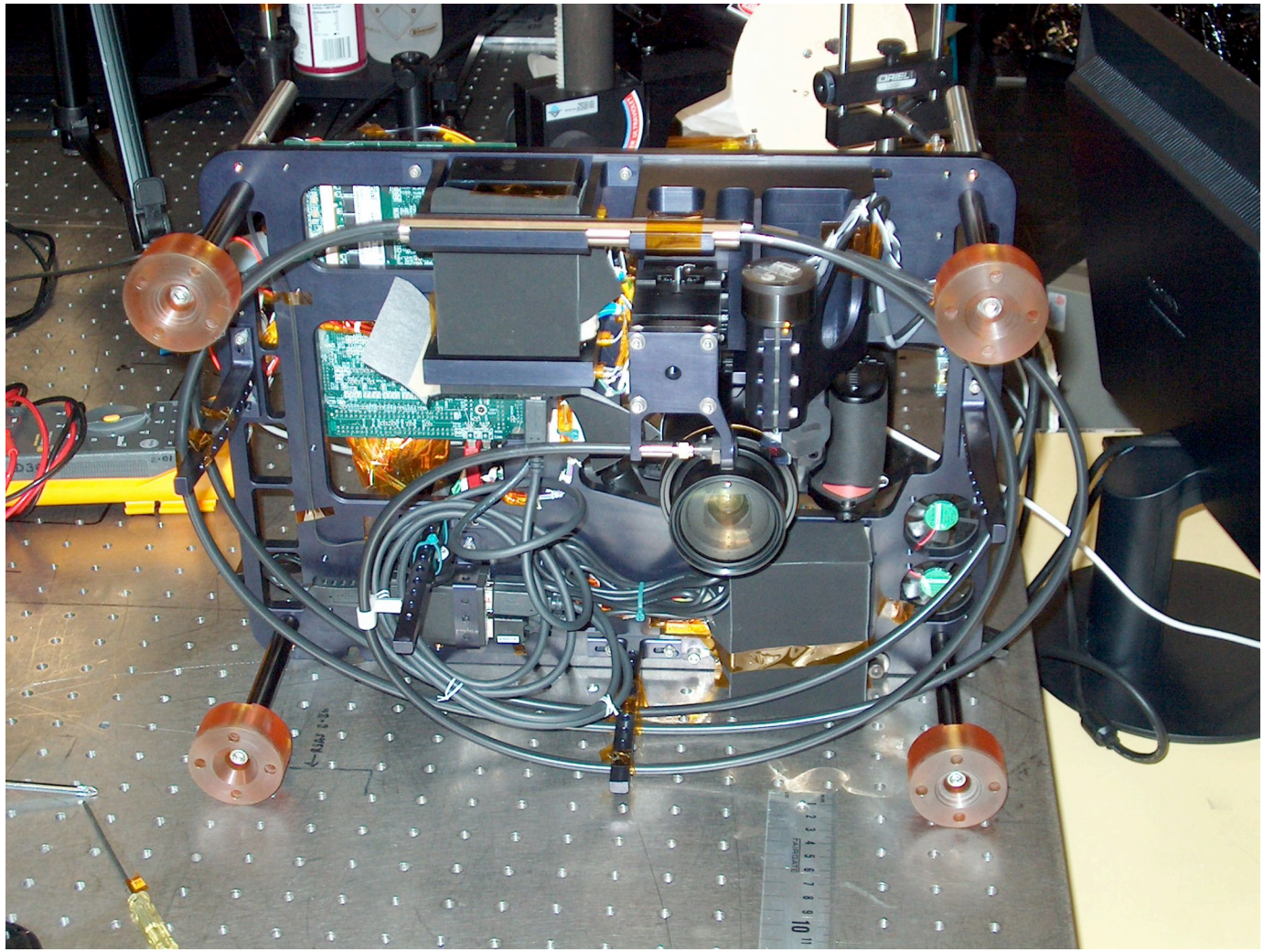
Kent McCullough	Technician
Robert Frederickson	Mechanical Design
John Riley	Electrical Design
Matt Kowalewski	Calibration

ACAM Test-flight Objectives

- Provide visible cloud and surface information for AURA satellite instruments.
- Determine whether “off-the-shelf” miniature spectrograph systems are stable enough and have sufficient S/N to perform trace gas retrievals for validation.
- Make remote sensing observations of tropospheric pollutants: O_3, NO_2, SO_2, and aerosols at high spatial resolution.

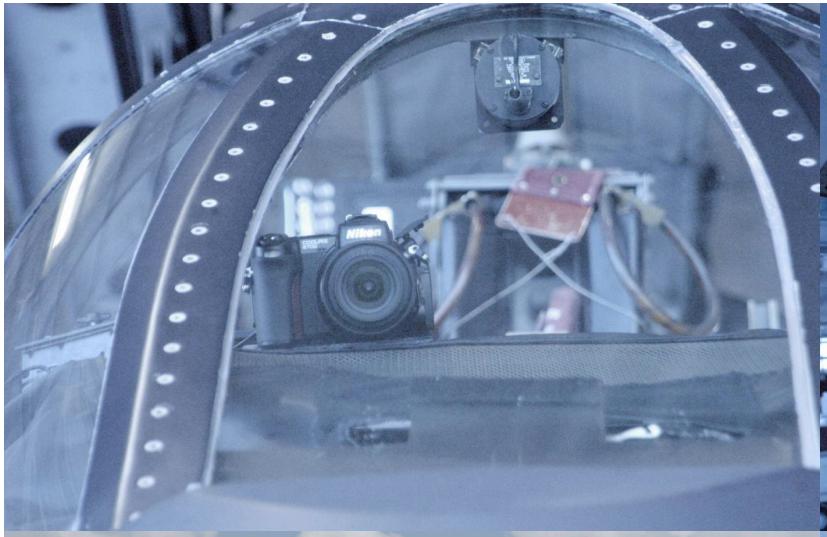
Instrumentation

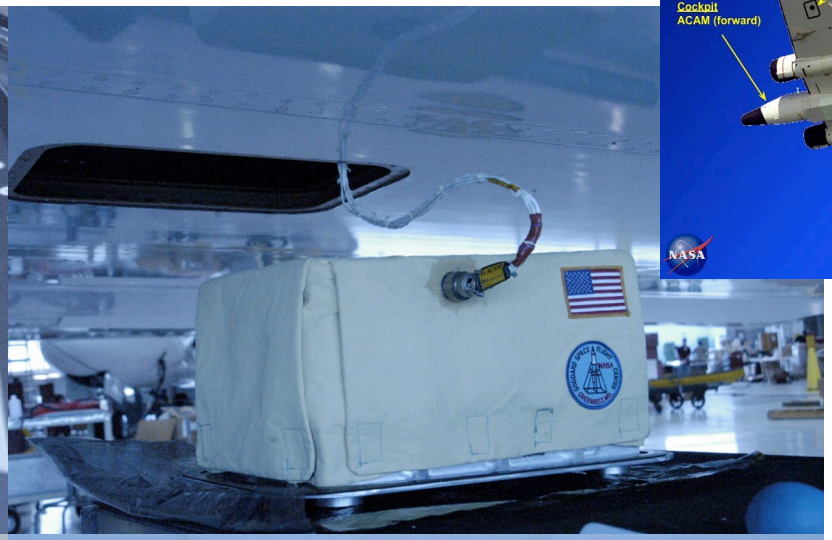
- **Two high-resolution digital Cameras**
  - **Cockpit mount: Forward viewing of vertical and lateral cloud structure**
  - Nikon 8700 Digital camera (3,264 x 2,448 pixels) preprogrammed to shoot 1 frame every 30 seconds.
  - **Wing Hatch: Nadir viewing cloud cover and scene identification**
  - Camera: Nikon 8800◦ Digital camera (3,264 x 2,448 pixels) preprogrammed to shoot 1 frame every 20 seconds.
  - Has 10X optical zoom and vibration reduction.
- **Two Scanning spectrographs**
  - Channel 1: 300-380 nm, 1.0 nm nominal spectral resolution
  - Channel 2: 360-550 nm, 1.2 nm nominal spectral resolution
  - +/- 30 degree scan mirror with common telescope and fiber optic feed to spectrographs
- Experiment housing is sealed to maintain atmospheric pressure and has survival heaters.

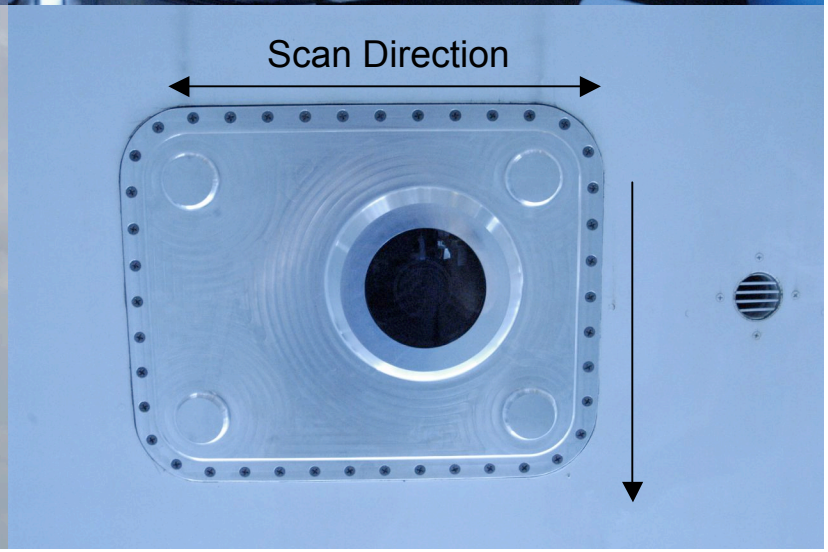


AVE Science Team Meeting 19-20 September 2005

1st Flight-6/09/2005

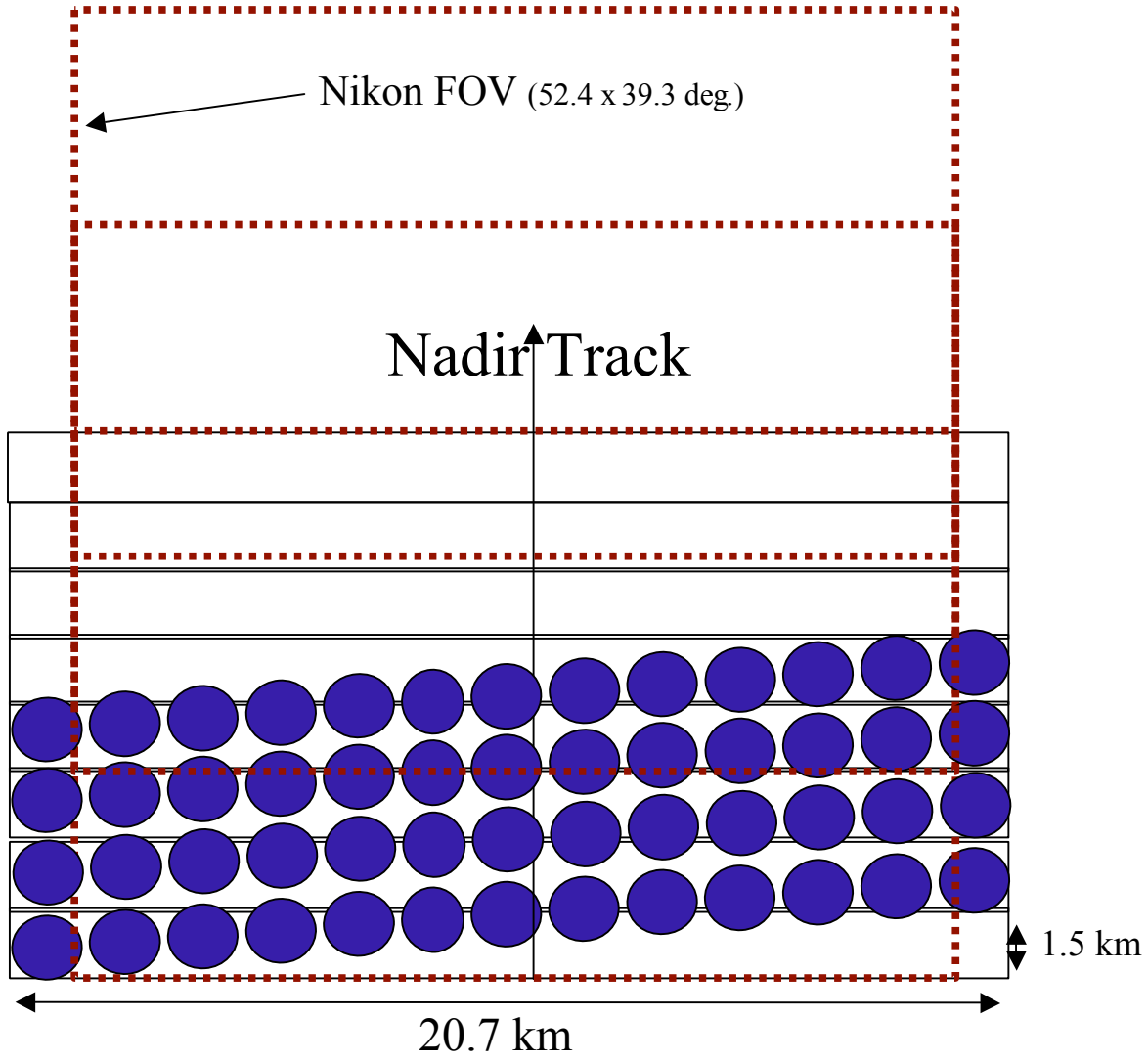






Scan Pattern

- ACAM scan pattern at 18 km altitude
- 13 steps/scan
- IFOV= 4.6 degrees
- ~0.5 sec/step
- Nikon Rep. Time = 20 sec.
- 1800 scans/flight



Flight Performance and Current Status

- AVE-June05 Flights 2–8 successful
  - Internal moisture condensation limited usefulness on flights 1&2. Fixed for subsequent flights.
  - Scene imagery from digital cameras worked flawlessly for nadir, intermittently for cockpit camera.
  - Post-mission calibrations of the spectrographs have been performed to check for instrument stability.
  - Post-mission assessment of performance for O_3, NO_2, and aerosols ongoing.
    - NO_2 retrievals successful but sensitivity is low.
    - O_3 retrievals (DOAS) unsuccessful due to optical bench temperature effects.
    - Aerosol/Reflectivity retrievals ongoing, promising.
  - Planning for next mission and upgrades in progress.

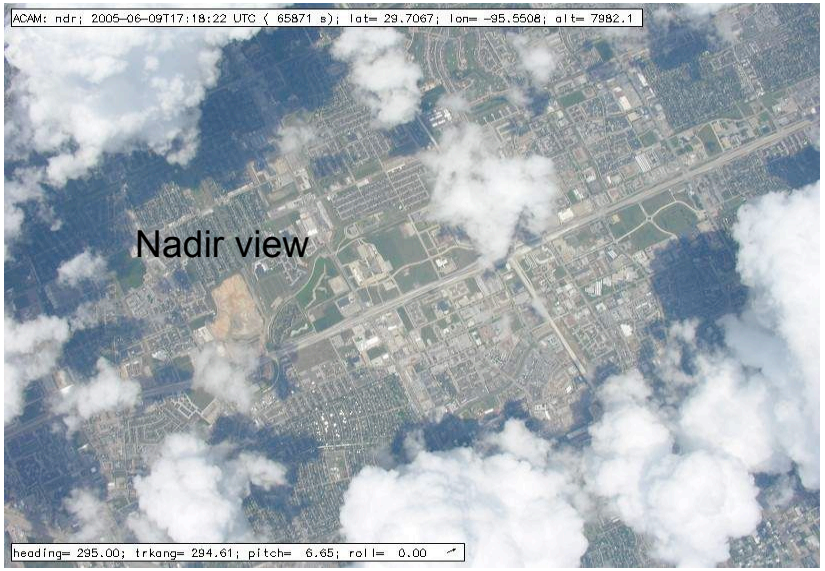


Image archives

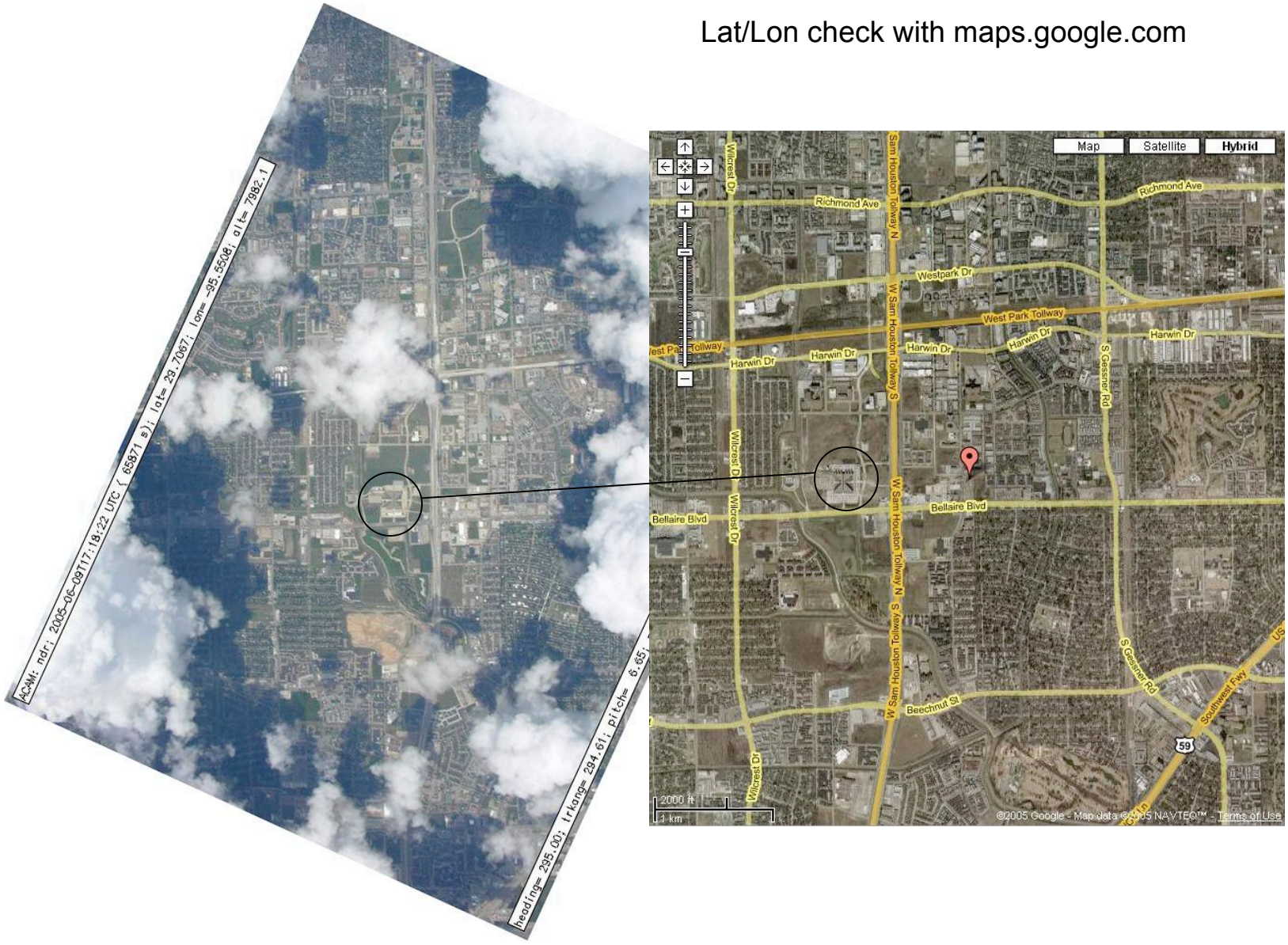
http://avdc.gsfc.nasa.gov/Data/Browse/index.html

Two versions, full resolution and ¼ resolution

Movies(quicktime 7 required)

http://code916/Public/Ground_based/acam/acam.html

Lat/Lon check with maps.google.com

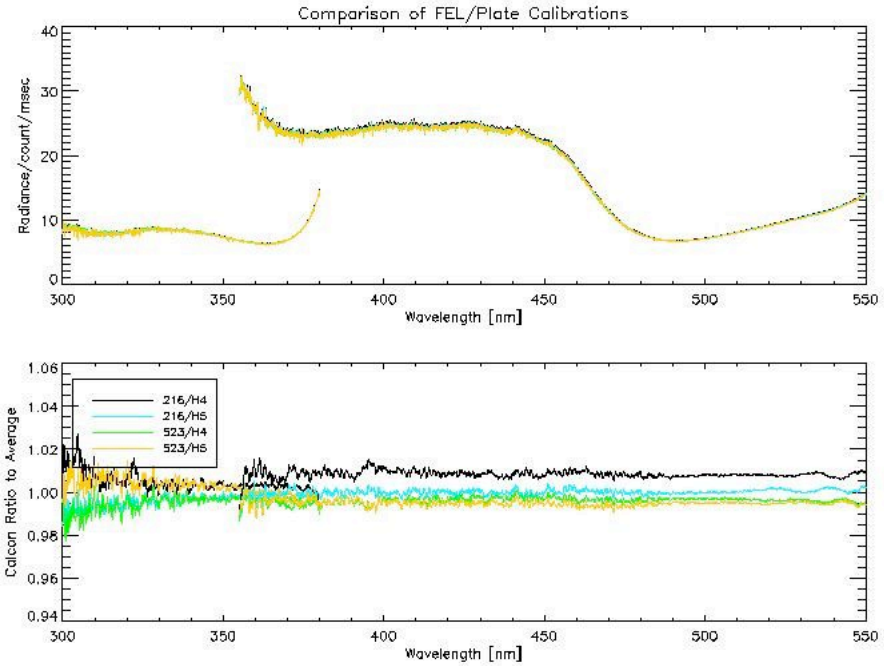


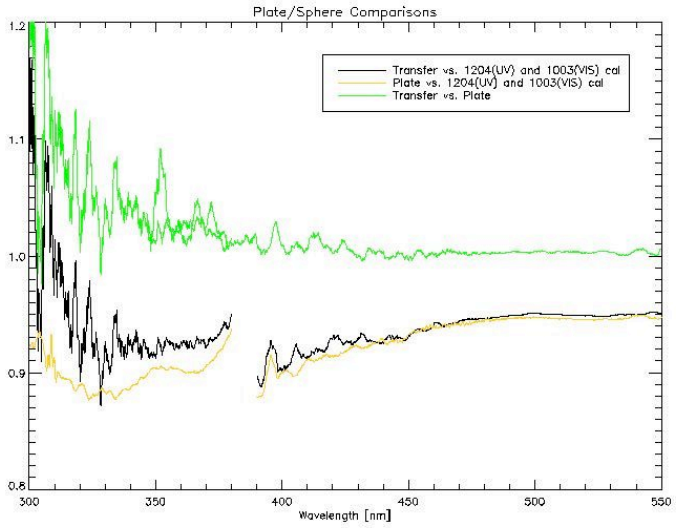
Absolute Calibration

•Two techniques used, sphere+QTH lamp using ACAM as a transfer radiometer and direct spectralon+QTH calibration

•Both techniques agree at the 1% level for the VIS channel and sub-3% level for the UV channel (Sphere transfer is noisy here)

•2% post-flight to pre-flight decrease in sensitivity observed due to loss of AR coating on the 1st surface of the window.



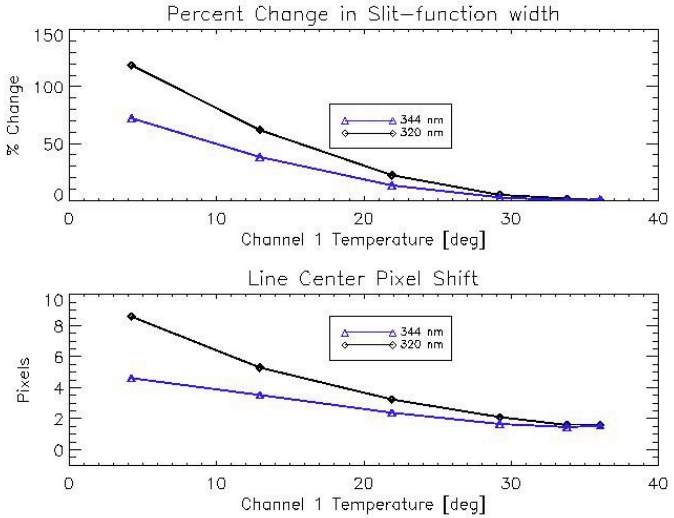


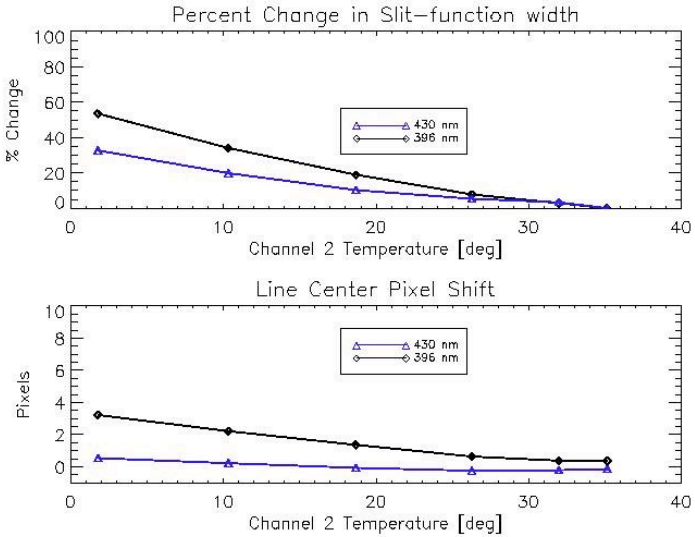
Plate/lamp comparisons show consistency among standards

Plate vs. Sphere Technique agree, plate calibration used for lv0-lv1 calibration due to superior SNR.

In-flight Temperature effects

•Changes in system response
•Degradation of slit function
•Shifts in wavelength registration

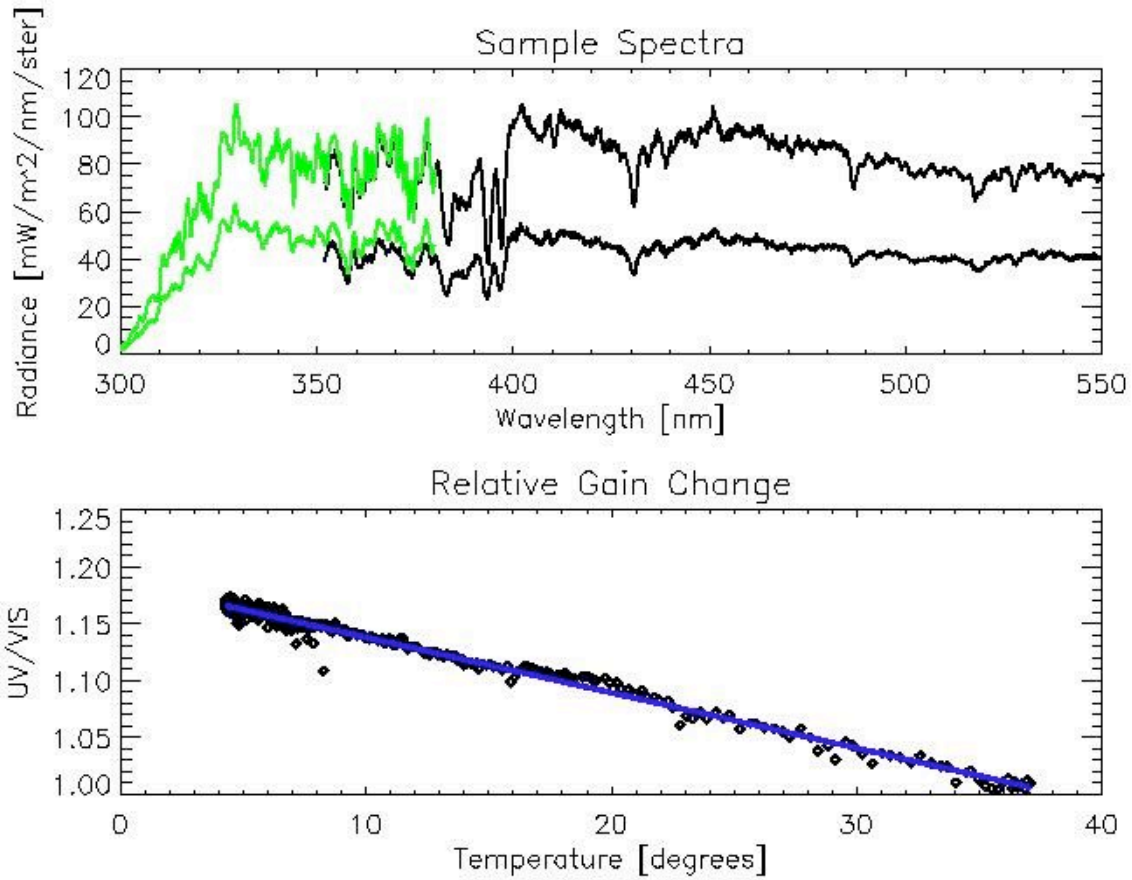




UV Channel slit resolution and line center shift

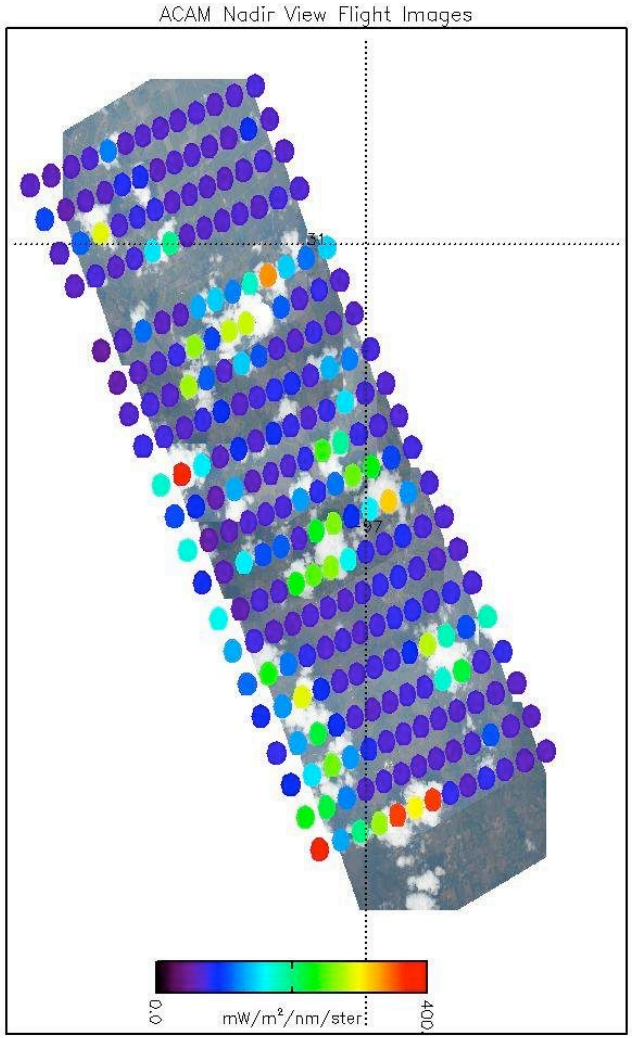
VIS Channel slit resolution and line center shift

•Effects are dependent on position within the sensor.
•Worse toward edges (warping).
•Pixel shifts of 1-3 pixels VIS channel and 4-8 pixels UV
•Resolution degrades from 1.2 nm [0.8 UV] to 1.8 nm [1.5 UV]

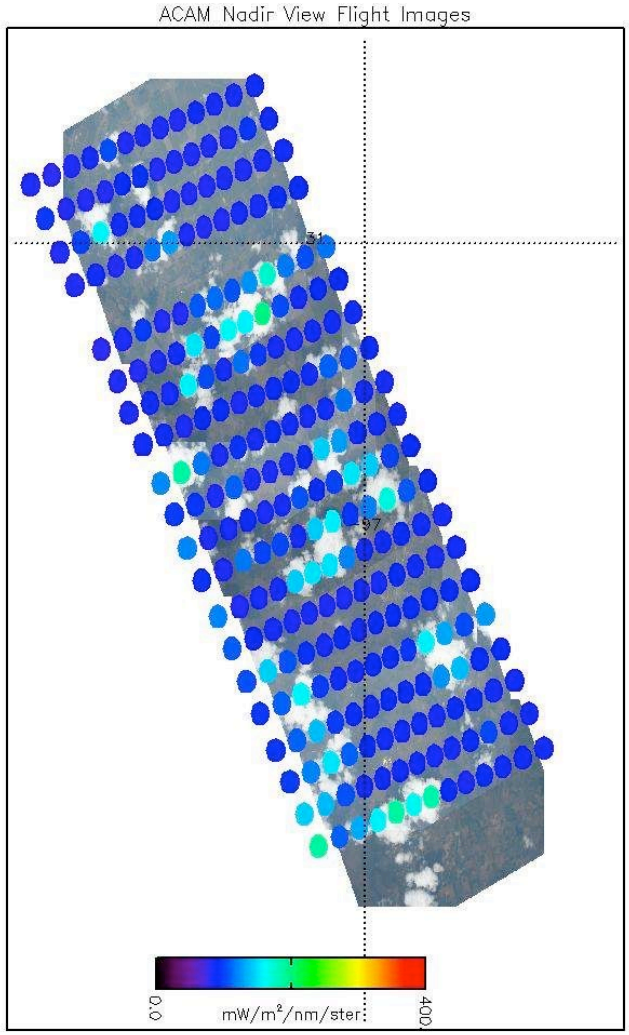


System response changes with optical bench temperature.

Results - Radiances

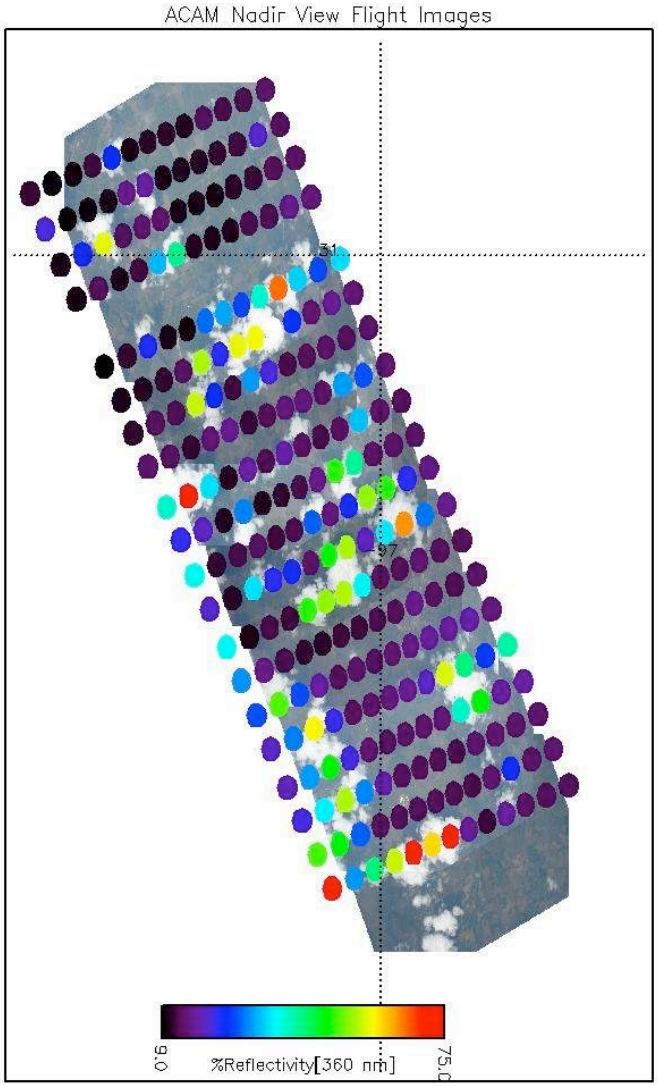


520 nm

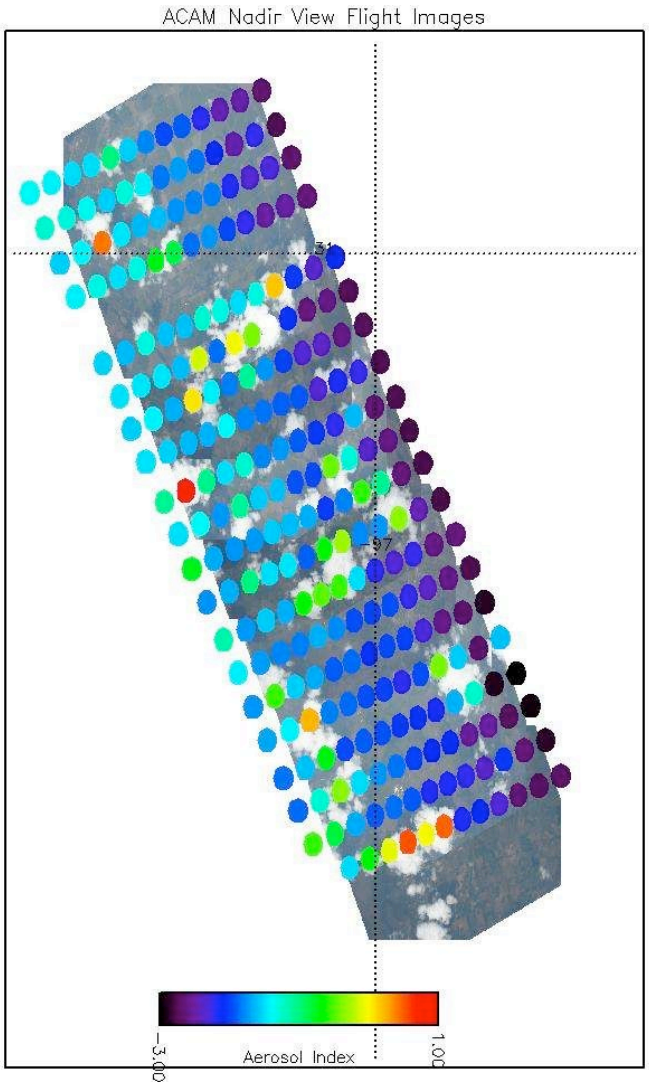


340 nm

Results – Aerosol Index/360 nm Reflectivity



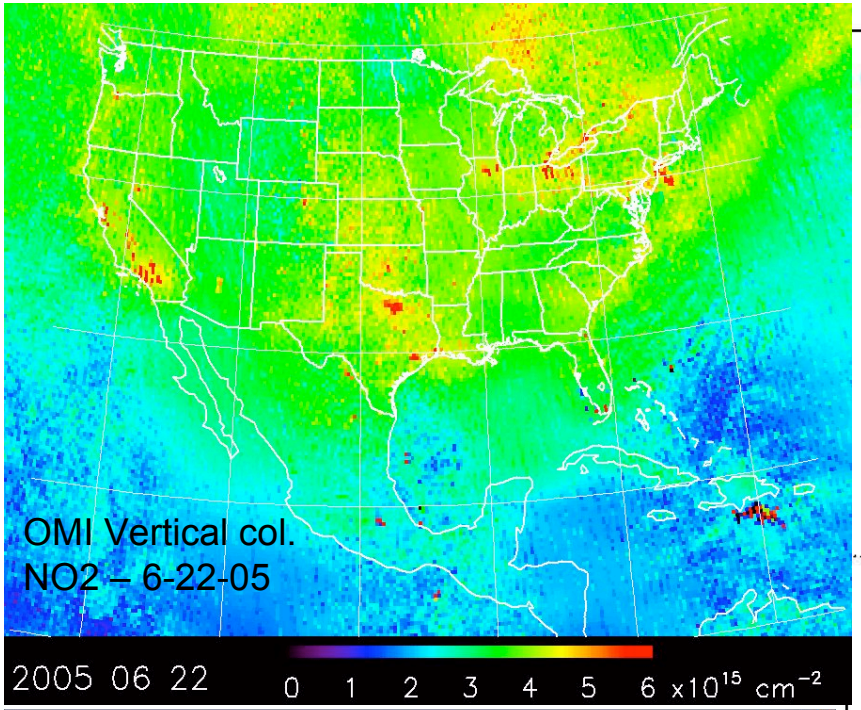
Reflectivity

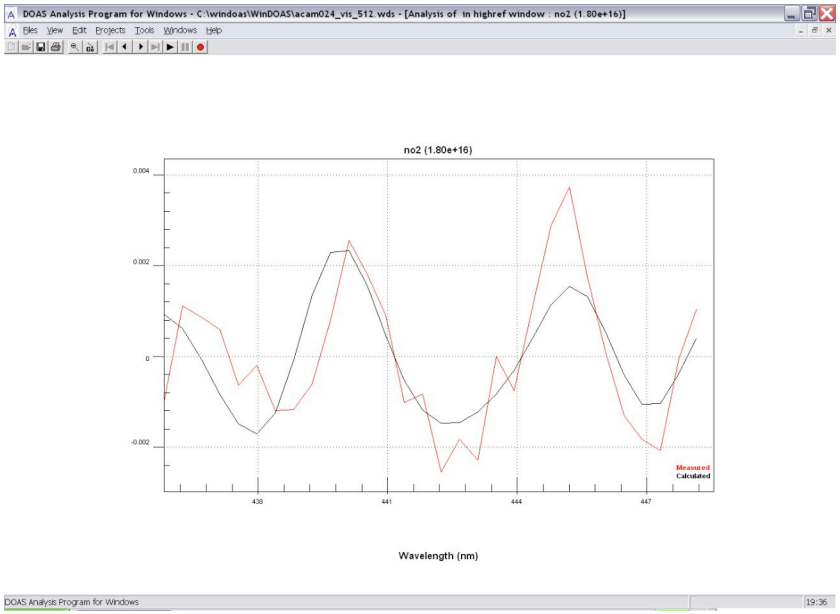


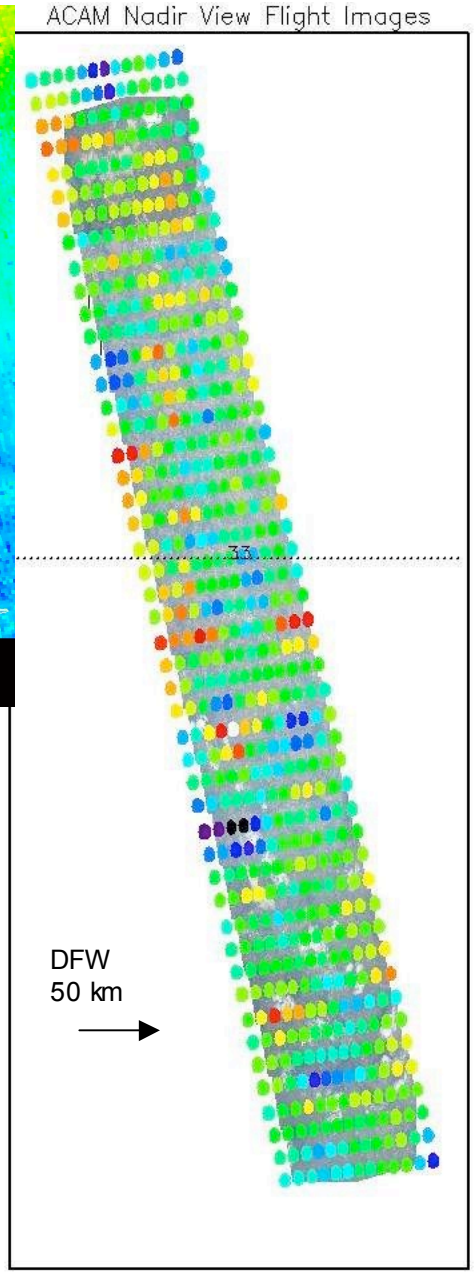
Aerosol Index

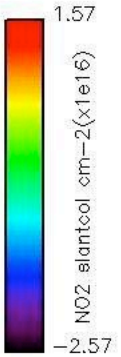
Scan angle dependence apparent, need to fix geometry.

NO2 Retrievals- Dallas/Fort Worth









- NO_2 derived by fitting spectral residuals to cross-sections using arbitrary reference. S/N of better than 1000:1 is required.

- ACAM sensitivity ~ 8 x10^{15} cm-2, factor of 10 worse than laboratory zenith sky measurements.

- Added noise is result of degraded slit function, interpolations to new wavelength grid, and scene noise (noise is reduced over clouds by ~1/2).

Conclusions

•Need to install spectrograph heaters and control software for next flight!

•Nikon imagery works very well and should be useful to the community, particularly for developing ozone and aerosol retrievals.

•Aerosol and radiance product will likely be of good quality.

•NO_2 is marginal for this set of flights, should improve for next as temperature is stabilized.

•Ozone retrievals will need a TOMS-type algorithm due to poor slit functions in the UV, much work needed here.

•SO_2, haven't looked for it yet but unlikely due to degraded resolution.